

MMA-707: Analytical Finance I

Lookback Options

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Västerås 2008

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1 Abstract

This seminar report is devoted to study Lookback Options. We created Excel-VBA program for calculation of price of European put and call options.

2 Theory

A floating strike lookback call option gives the holder the right to buy the underlying security to the lowest observed value S_{min} , during the option lifetime.

$$\begin{aligned} P_{call} &= SN(a_1) - S_{min}e^{-rT}N(a_2) \\ &= +Se^{-rT}\frac{\sigma^2}{2r} \left[\left(\frac{S}{S_{min}} \right)^{\frac{-2r}{\sigma^2}} N\left(-a_1 + \frac{2r}{\sigma}\sqrt{T}\right) - e^{-rT}N(-a_1) \right], \end{aligned}$$

where

$$a_1 = \frac{\log\left(\frac{S}{S_{min}}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \quad \text{and} \quad a_2 = a_1 - \sigma\sqrt{T}.$$

Similarly, the holder of a floating strike lookback put options have the right to sell the underlying security to the highest observed price S_{max} , during the life time of the option.

$$\begin{aligned} P_{put} &= S_{max}e^{-rT}N(-b_2) - SN(-b_1) \\ &= +Se^{-rT}\frac{\sigma^2}{2r} \left[-\left(\frac{S}{S_{max}} \right)^{\frac{-2r}{\sigma^2}} N\left(b_1 - \frac{2r}{\sigma}\sqrt{T}\right) + e^{rT}N(b_1) \right], \end{aligned}$$

where

$$b_1 = \frac{\log\left(\frac{S}{S_{max}}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \quad \text{and} \quad b_2 = b_1 - \sigma\sqrt{T}.$$

3 Program interface

The screenshot shows an Excel spreadsheet with two sections for pricing lookback options. The first section is for a Call Option, and the second is for a Put Option. Each section has input fields for various parameters and a 'Calculate' button. The results of the calculations are displayed in the 'The price is' cells.

Row	Column	Label	Value	
2	Pricing Lookback Call Option			
4	C	S	40	
5	C	Smin	34	
6	C	r	0.4	
7	C	sigma	2	
8	C	T	2	
9	C	q	0	
12	B	The price is	24.89777	
12	F	Calculate		
17	Pricing Lookback Put Option			
19	C	S	20	
20	C	Smax	45	
21	C	r	0.02	
22	C	sigma	2	
23	C	T	2	
24	C	q	0	
27	B	The price is	90.18228	
27	F	Calculate		

Figure 1: Excel-VBA Lookback Option Calculator

4 Codings

```

Private Sub CommandButton1_Click()

Range("E4").Select

S = ActiveCell.Value

Range("E5").Select

Smin = ActiveCell.Value

Range("E6").Select

r = ActiveCell.Value

Range("E7").Select

sigma = ActiveCell.Value

Range("E8").Select

T = ActiveCell.Value

Range("E9").Select

q = ActiveCell.Value

c1 = (Log(S / Smin) + (r - q + sigma ^ 2 / 2) * T) / (sigma * Sqr(T))

c2 = c1 - sigma * Sqr(T)

Result = S * PrNorm(c1)

Result = Rresult - Smin * Exp(-r * T) * PrNorm(c2)

Result = Result + S * Exp(-r * T) * (sigma ^ 2 / (2 * r)) *
    ((S / Smin) ^ (-2 * r / (sigma ^ 2)) *
    PrNorm(-c1 + 2 * r * Sqr(T) / sigma) -
    Exp(-r * T) * PrNorm(-c1))

```

```
Range("E12").Select

ActiveCell.Value = Result

End Sub

Private Sub CommandButton2_Click()

Range("E19").Select

S = ActiveCell.Value

Range("E20").Select

Smax = ActiveCell.Value

Range("E21").Select

r = ActiveCell.Value

Range("E22").Select

sigma = ActiveCell.Value

Range("E23").Select

T = ActiveCell.Value

Range("E24").Select

q = ActiveCell.Value

b1 = (Log(S / Smax) + (r - q + sigma ^ 2 / 2) * T) / (sigma * Sqr(T))

b2 = b1 - sigma * Sqr(T)

Result = Smax * Exp(-r * T) * PrNorm(-b2)

Result = Result - S * PrNorm(-b1)
```

```
Result = Result + S * Exp(-r * T) * (sigma ^ 2 / (2 * r)) *  
      (-S / Smax) ^ ((-2 * r) / sigma ^ 2) *  
      PrNorm(b1 - 2 * r * Sqr(T) / sigma) +  
      Exp(r * T) * PrNorm(b1))
```

```
Range("E27").Select
```

```
ActiveCell.Value = Result
```

```
End Sub
```

```
Function DerN(x)
```

```
Pi = 3.141592654
```

```
DerN = 1 / Sqr(2 * Pi) * Exp(-x ^ 2 / 2)
```

```
End Function
```

```
Function PrNormS(x)
```

```
gamma = 0.2316419
```

```
a1 = 0.31938153
```

```
a2 = -0.356563782
```

```
a3 = 1.781477937
```

```
a4 = -1.821255978
```

```
a5 = 1.330274429
```

```
y = 1 / (1 + gamma * x)
```

```
PrNormS = 1 - DerN(x) *
```

```
      (a1 * y + a2 * y ^ 2 + a3 * y ^ 3 + a4 * y ^ 4 + a5 * y ^ 5)
```

```
End Function
```

```
Function PrNorm(x)
```



```
If x >= 0 Then
    PrNorm = PrNormS(x)
Else
    PrNorm = PrNormS(-x)
End If
End Function
```

Bibliography

- [1] Röman J. *Lecture Notes*, 2008.